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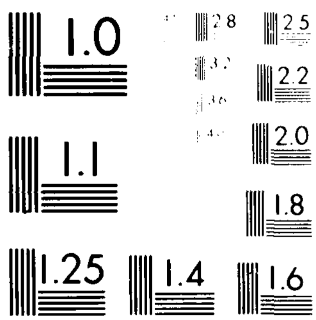

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RECORD OF FIRST MEETING OF EXPERT WORKING GROUP ON MINEFIELD DETECTION TECHNOLOGY

AD A088670

FEBRUARY 1979

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
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16. Abstract

The first meeting of the Expert Working Group on Minefield Detection Technology was held at MERADCOM on 7-8 December 1978. Briefings were given by representatives of MERADCOM, the Environmental Research Institute of MIchigan (ERIM), and Braddock, Dunn, and McDonald (BDM) on the goals of a project being performed under Contract DAAK70-78-C-0198 to identify, screen, analyze, test, and evaluate methods of minefield detection, with primary emphasis on the European Theater of Operations. ERIM presented a Project Plan I for accomplishment of project tasks, which would include early effort devoted to identification and screening of new technical opportunities, and experimental collection of critical data on spotlight radar and active IR scanner systems. Suggestions were made by the EWG members and other participants concerning specific techniques to be screened, analytical methodology, and experimental tests. After review and discussion of the Project Plan in an open meeting followed by an Executive session, the Expert Working Group made the following recommendations. MERADCOM, ERIM, and BDM should prepare a comprehensive work plan which more fully coordinates the objectives and activities of ERIM and BDM. The program plan should specify technical opportunities in terms of (1) present systems, (2) IOC 1985 systems, and (3) IOC 1990 technologies. The resulting coordinated plan should be ready for review by the EWG by the end of February 1979.

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RECORD OF FIRST MEETING OF EXPERT WORKING GROUP ON MINEFIELD DETECTION TECHNOLOGY

1. INTRODUCTION

The first meeting of the Expert Working Group for the Minefield Detection Project was held at MERADCOM, Ft. Belvoir, Virginia on 7-8 December 1978. Individuals attending the meeting are listed in Table 1. Presentations were made by MERADCOM, ERIM, and BDM to the Expert Working Group; ERIM, BDM, and MERADCOM professional staff; and outside observers. Section 2 itemizes the briefings given by MERADCOM, ERIM and BDM, and gives references to documents containing more information on technical material presented. Section 3 is a record of comments made by individuals in response to the information presented in the briefings, and also summarizes the conclusions and recommendations of the EWG at the end of the meeting. The comments are organized by subject and where available, the name of the individual is included. The comments do not necessarily represent a consensus of the EWG or other attendees. In Section 4, the proceedings of the meeting are summarized in the form of a series of recommendations and action items.

2. BRIEFINGS

Mr. Brooke of MERADCOM opened the two-day meeting with a brief review of the history of mine and countermine warfare and the current status of development and deployment of mine detection methods. The current project being undertaken by ERIM is part of a continuing effort to identify and exploit technical opportunities for improved mine detection capability.

TABLE 1. NAME AND AFFILIATION OF INDIVIDUALS ATTENDING THE FIRST MEETING OF THE EXPERT WORKING GROUP ON MINEFIELD DETECTION

NAME	AFFILIATION
Expert Working Group	
LTG James F. Hollingsworth, Chairman	
Francis B. Paca	MERADCOM
Seth Bonder	Vector Research, Inc.
William L. Wolfe	University of Arizona
Robert O. Harger	University of Maryland
Charles E. Olson, Jr.	University of Michigan
Robert K. Vincent	Geospectra Corporation
Charles N. Johnson, Jr.	
Theodore Vogel	USAETL
Robert C. Heimiller	ERIM
MERADCOM	
Roland Gonano	
Harry Peters	
Karl Steinbach	
T. W. Lovelace	
K. J. Dean	
Richard R. Rogowski	
Donald B. Dinger	
R. L. Brooke	
Ray Nolan	
P. J. McConnell	
R. A. Falls	

TABLE 1. (Continued)

NAME	AFFILIATION
Environmental Research Institute of Michigan	
Henry F. McKenney, Program Manager	
I. J. Sattinger	
E. L. Johansen	
D. D. Bornemeier	
J. R. Maxwell	
H. C. Hatch, Washington Office	
M. A. Lopez, Washington Office	
Braddock, Dunn, and McDonald	
C. E. Somers	
W. P. Schneider	
W. Baum	
Other Attendees	
Jackson Abbott	USAES (ATZA-CDM)
Douglass McGowen	USAES (ATZA-CDT)
T. H. Krupp	USAES
R. Kearn	AMSAA (Aberdeen Proving Ground)
C. L. Lucas	NPIC

Mr. C. Somers of BDM then gave a briefing on the threat of Soviet mine warfare and a scenario representative of early stages of a Soviet attack against NATO forces in the European theater.

In the afternoon session, Mr. H. McKenney of ERIM presented an overview of the Mine Detection project being initiated by ERIM. This overview covered program objectives and guidelines, technical approach, task structure, technical implications derived from scenarios provided by BDM, and the recommended technical program and schedule for accomplishment under Project Plan I. A more detailed presentation of these topics is included in ERIM Report No. 138300-4-T, "Detection of Remote Minefields, Project Plan I", which was distributed to MERADCOM and to EWG members prior to the meeting.

Technical background information and the rationale leading to the recommended Plan I program presented in ERIM Report No. 138300-4-T were presented by L. Johansen, R. Maxwell, and D. Bornemeier of ERIM. L. Johansen covered primarily radar systems, while R. Maxwell and D. Bornemeier discussed electro-optical systems.

Dr. Johansen covered the objective of system investigations and gave brief summaries of technical considerations related to acoustic and seismic techniques, millimeter and submillimeter wave radar, dual-polarization dual-frequency radar, and spotlight radar. He also described the experimental program for obtaining data on radar techniques based on the preparation of test arrays of various types of mines, minelaying equipment, field fortifications, etc., overflight of these test arrays with a spotlight radar system, and subsequent processing and analysis of the imagery.

Dr. Maxwell presented a general discussion of electro-optical technology which might be applicable to mine detection, covering the characteristics of various parts of the optical spectrum, the spectral,

thermal and spatial characteristics of targets and backgrounds, and the system concepts and technical parameters of active, passive, and three-dimensional electro-optical systems. This background information was then used to describe the rationale used in developing the program in electro-optical data acquisition and analysis recommended in ERIM Report No. 138300-4-T, "Detection of Remote Minefields, Project Plan I".

Dr. Bornemeier described the method of operation of 3-D systems and showed examples of three-dimensional imagery collected under other ERIM projects. He reviewed the various measurement options considered in developing Plan I recommendations, specifically, laboratory measurements, rooftop measurements, and flight test measurements, covering the advantages and disadvantages of each approach. He then described details of the recommended program for field collection of data using a modified active scanner system and a specially prepared array of mines. This field test program is discussed in ERIM Report 138300-4-T.

At the beginning of the second day of the meeting, Mr. Somers briefed the attendees on proposed methods of analyzing minefield detection systems and evaluating them for military worth. Mr. Somers concentrated most of his discussion on the major features of COMWTH II. A description of this model is given in BDM Report W-78-002-TR, "COMWTH II, Target Acquisition - Weapons Employment Interaction Simulation," copies of which were distributed by Mr. Somers.

3. INDIVIDUAL COMMENTS

This section is a record of individual comments made in response to information presented in the briefings.

Mine Warfare

The primary purposes of mines are area denial and the destruction of military equipment or personnel, either directly or by canalizing them as

targets for antitank fire. In addition to this, they have the capability to divert the attention of the other side to watching for mines rather than looking for targets.

The mine detection process is important because the safety of blue force tanks is dependent on being able to avoid minefields. Mines are difficult to see from tanks, especially if they are buttoned up or if there is considerable vegetative cover on the ground.

A knowledge of enemy mine location and activity allows our forces a number of options. It allows us to breach or avoid the minefields, and thus protect our forces. It gives some indication of enemy plans. It allows us to sow anti-personnel mines to impede their mine retrieval operations.

Paca: Another aspect of the mine detection problem is to determine whether the enemy has laid real or decoy mines. This type of information is probably not susceptible to determination by mine detection sensor techniques.

Paca: Only the U.S. has square mines in its inventory. Therefore, investigation of this mine shape should be given low priority.

Brooke: There is no threat from artillery delivered mines.

<u>Importance of the Mine Detection Problem</u>

Dinger: Mine detection is recognized as a high priority problem for the Army. It is prepared to expend 6.2 program funds if practical methods of mine detection result from the current three-year program.

NATO also puts high priority on the mine detection task.

Function of the Expert Working Group

The function of the Expert Working Group is to provide broad technical and operational guidance on the mine detection research effort. The EWG should determine that the problem to be solved is realistically understood and assessed, that the effort is accurately directed toward this problem, and that no significant aspect of the problem is being overlooked. The approved work plan should determine whether we can use sensors that are already in use, and should determine what new technology is needed.

The EWG should report to MERADCOM its findings on the direction and adequacy of the contractors' program.

Soviet Minelaying Capabilities and Methods

Soviet mine technology is simpler than U.S. technology. We depend on more sophisticated methods to compensate in part for greater enemy numbers. They accept a simpler technology, because it is effective when used in large numbers.

Most data on mines presented by BDM concerns standard Soviet mines already in the inventory, but excludes older mines considered to be obsolete. Data on newer mines are not available. It is known, however, that newer mines are designed with greater attention to protection against environmental conditions, so as to prolong the useful operational life of the mine.

In hasty operations, the Soviets have the capability for laying down lots of mines at a high rate by a well prepared force. A single helicopter or truck can carry from 200 to 400 mines. Once their protective function has been completed, mines are picked up by hand for re-use. While they are laid down, they are protected by covering fire, making it hazardous for blue force personnel to remove them.

The Soviets will lay mines only when they are needed. If they are advancing rapidly against weak opposition, minefields are not needed. If there is substantial resistance, they will then employ minefields to assist a breakthrough or support a prepared defense.

The logistics of Soviet mine delivery was discussed. They are moved to the battlefield along with other materiel. The mine depot for distribution of mines is located within 5 km of the FEBA. It might be possible to recognize a mine dump. But in general, the supply of mines to the front does not present distinctive activity which can be used for inferential detection.

Logistic movement of mines to the front will usually occur at night. Actual minelaying operations may occur at any time during the 24-hour day. Most operations will occur during the day, but massive minelaying operations are likely to occur overnight.

The Soviets take the countermine problem seriously. They have good obstacle detection capability, which includes mines. They have rollers and plows for mine neutralization purposes.

U.S. Army Capabilities

We won't have defensive mines in the first few days of a war. Scatter mines would be useful during this period.

U.S. minelaying equipment will do a very neat job of burying mines with minimum indication of the surface disturbance. However, minelayer vehicle tracks will probably be visible.

Rogowski: Present U.S. capability for breaching minefields is not very satisfactory. The systems have operational drawbacks and are not available in sufficient numbers.

Scatter Mining

Scatterable mines are delivered from fixed-wing aircraft or by artillery tube; they can be emplaced quickly just in front of or among

enemy forces to disrupt their movement or to close gaps in conventional minefields and other defenses.

A decision should be made on whether scatterable mines are to be included in the work plan.

No information is available on Soviet scatterable mines, although it is known that the Soviets have had the technical capability to make scatter mines for many years and have considered specific deployment techniques. However, evidence from known Soviet doctrine and tactics indicate that they do not think this is a good way to fight a war. The method has low effectiveness, produces a mobility kill but not an equipment kill. (New U.S. scatterable mines will produce equipment kills.)

One possible application for scatter mines would be to dump them ahead of a difficult bridging operation.

There was a considerable difference of opinion within the meeting as to the utility of scatter mines.

Conflicting statements were made about the cost of scatterable mines.

Scatterable mines may have disadvantages for the attacking force. Once the attacking force has overrun the contested area where they have been laid, the mines will represent a hazard and will impede the attacker's mobility. This is also true of buried mines.

Scenarios

Somers: The threat and scenarios selected by BDM for use in mine detection analysis are consistent with the approved Department of the Army position in this subject area. The threat used for development of scenarios has been extracted from the Soviet literature. It is recognized

that wars are not generally fought as originally planned, but the scenarios are useful for mine detection analysis. They are based on the Soviet perspective of a war with the Western powers. The Soviets will not start a war unless they think they can win it. It is, therefore, appropriate to assume a scenario in which the early stages of the war consist of Russian successes. The specific scenarios selected may not actually occur in the exact manner assumed, but the scenarios are representative of conditions which must be met by the mine detection process.

The validity of the scenarios presented by BDM was questioned by Bonder. Are these scenarios realistic representations of conditions to be expected under combat? Or, do they represent a worst case assumption? Somers replied that the scenarios are consistent with our knowledge of Russian planning. Although the actual development of the battle may differ from the assumed scenarios, they are believed to be suitable for the analysis of mine detection techniques. The activity times, a critical variable, are realistic.

Wolfe: The BDM scenarios should be made more realistic by including more indication of Blue force equipment and response to the Russian mining activity. This response might consist of mine neutralization or removal, using mines to block their advance, going around mines, etc.

Olson: The four scenarios presented by BDM do not cover the complete set of operational requirements. Even low speed detection of mines will have valuable uses.

Paca: BDM has an accurate and comprehensive understanding of Soviet tactics and doctrine. Its recommendations on threats and scenarios can, therefore, be given high credibility.

Detecting mine laying operations is made more difficult by the fact that there is a tremendous amount of activity going on simultaneously involving many different units.

Surface mines can be picked up easily, whereas buried mines also hamper the mobility of the side that lays them down.

Bonder: We need a better integration of operational usefulness analysis with the experimental program, to be sure the experimental program is properly directed. Therefore, operational criteria should be set up during the initial stages of the project to guide experiment design.

The BDM work should identify (1) requirements for sensor performance characteristics (coverage, accuracy, response times, vulnerability, etc.), (2) minefield characteristics and (3) platform characteristics. ERIM needs information on area to be covered in minefield search, time constraints for data acquisition and delivery, vulnerability of sensors and platforms, mobility, etc.

Flank Protection Minefield Scenario: The red force shown in the scenario sketch is likely to be at the head of a long line of military vehicles awaiting the breakthrough.

Prepared Defense Scenario: Mines for this purpose will be laid when the Reds are stopped and want to defend themselves. The minelaying operation will happen quickly. The Soviets have the capability for laying 50,000 mines overnight.

Breakthrough Scenario: Somers: A change in this scenario is suggested. The shoulders will be protected by densely laid surface mines.

Comments on ERIM Plan I

The plan presented by ERIM needs to be made more specific. It does not adequately indicate the objectives of the tests and how the experimental data will be processed and evaluated.

Wolfe: The screening matrix presented by ERIM has several items where more detailed definition is needed (e.g., day/night capability, weather capability).

Test Array: Vincent: In laying mines, it is desirable to avoid disturbing the ground. Landsat data acquired over the array, both before and after, should be studied to ascertain whether it shows anything.

Acoustic/Seismic Sensors: Bonder: Use of artillery for emplacement of acoustic/seismic sensors has the disadvantage that the artillery already has too many other jobs to do.

A suggested method of processing acoustic/seismic data would be to use the outputs of two sensors in the vicinity of the minelaying operation. Simultaneous processing of the two outputs might indicate the back-and-forth movement pattern of the vehicle. Multispectral classification of the minelaying vehicle acoustic/seismic outputs might also be used to identify minelaying operations.

Millimeter Radar: A potential disadvantage of millimeter radar is that it has less foliage penetration capability than the longer X and L wavelengths.

Electro-Optical Systems: Harger: Does specular reflection limit the applicability of active scanners in seeing mines?

Bonder: Will the rooftop testing of the active scanner proposed by ERIM provide data useful for inputs to the modeling?

Answer: The electro-optical rooftop tests will not provide data on operational performance. However, they will give information on target and background reflectivity which will allow a preliminary assessment of detectability. Physical modeling or subsequent flight testing will provide model inputs.

Wolfe: Rooftop measurements should be supplemented by laboratory measurements. These are inexpensive and give controlled accurate data.

Other Mine Detection Techniques

Both Harger and Vincent recommended that we should look at the maximum entropy data processing approach being worked on by Phil Jackson of ERIM. Is this approach applicable to the mine detection problem?

Vincent: Gaseous detection methods should be included among those considered for the mine detection problem. Vinyl chloride, used as a material in mine construction, might be detected in this manner.

Vincent: By using wavelengths near the spacing of the individual mines, it may be possible to observe diffraction effects caused by the mine patterns.

Vincent: Theoretical analyses of various radar wavelengths should be conducted to define the best radar wavelengths for mine detection. The a priori choice of X and L bands may not be the best.

Answer: This type of analysis has been done and we are already at about the right region. It is also important to remember that dihedral type reflector effects predominate in the signal return from mines at X-band. ERIM is scheduled to make both analyses and measurements on typical mines at both X- and L-bands.

Olson: Classified sensors should not be overemphasized to the exclusion of unclassified sensors. Some unclassified techniques are effective methods for mine detection.

It is highly important to note that there is no ELINT or COMINT directly associated with minelaying activities. The only hope in this direction would be to overhear unencrypted radio voice communication.

Harger: In previous work in this area, I performed an analysis to determine the relationship between the detectability of minefields as a function of the density of mines in the minefield. My report on this analysis should be reviewed.

Johansen: I will review it to determine its applicability to the current program.

Existing Mine Detection Capability

Brooke: If possible, it would be desirable to tell the user that he already has a mine detection capability in the sensor techniques presently in inventory.

One of the tasks is to review the capabilities of existing data acquisition systems. The definition of these existing capabilities is an appropriate task for the system contractor.

The systems analysis task will identify what sensors are now in inventory or are coming into the inventory within the next few years.

Bonder referred to several studies which have been conducted to provide lists of sensors in use currently or in the near future. This documentation should be referred to as a means of compiling the list of mine detection sensors.

The end result of the work should be an assessment of the sensor technology and capability presently in the field.

It was pointed out that some of the assessment of existing technology has been covered in the previous ERIM study.

Vulnerability

Another responsibility of the systems contractor is to look at sensor/vehicle vulnerability. Quantitative estimates of vulnerability are required for modeling, but it should be recognized that vulnerability numbers are suspect.

Paca: Soviet air defenses are becoming increasingly effective. The U.S. Army is working on RPV's but their survivability is open to question.

The assessment of mine detection sensor vulnerability should include consideration of vulnerability of the sensor to electromagnetic interfer-

ence. With respect to vulnerability of the spotlight platform to radar-seeking missiles, R. Heimiller stated that DSARC reviews have already looked at this problem and find their vulnerability to be acceptably low. We should accept their decision.

Somers Briefing on Modeling of Minefield Detection Operations

The proposed methodology is based on the use of total force effectiveness as the basic measure of effectiveness. Specific mine detection techniques would be modeled to determine the increased total force effectiveness provided by their use compared to force effectiveness without their use. The resulting model will be an expected value model.

The model to be used for this purpose will be synthesized from three types of existing models developed and used by BDM. These are the Line of Communication model, the barrier assessment model, and the Combat Worth Model (COMWTH II).

In the Line of Communication model, the countermine activity will be simulated to determine the interaction between detection by the sensors and mine neutralization operations.

The barrier model simulates effects of barriers on mobility of maneuver units.

The COMWTH II model has been used for analysis of camouflage methods, and must be adapted for the mine detection problem. This model will provide the bulk of the model for mine detection analysis. A document describing this model was handed out to the EWG members. The model simulates target units to be detected and identified, target acquisition resource availability and performance, intelligence evaluation of the information supplied by the sensors, target analysis and attack planning, and finally simulation of the attack and determination of results against the real rather than the estimated target deployment.

For ERIM's purposes, a key part of the COMWTH II is the target detection simulation. In this simulation, the average number of target elements detected is computed as the product of (1) probability of coverage by the sensor, (2) probability of clear line of sight, (3) probability of detection, and (4) total number of elements in the target.

For airborne sensors, probability of line-of-sight would take into account the cloud cover as well as shielding of the target by topography.

Evaluation of the effects of weather is an important part of the analysis output. Bonder suggested that we avoid using a simple percentage of time during which each sensor would be available. Instead, sensor response capability and down times (for various weather conditions) should be used in the model separately.

COMWTH is a one-sided model, i.e., it shows only direct actions, but does not include reactions from the other side. The Barrier model is a two-sided model. The models are generally run at the Corps level.

Running time and cost of the model is kept within manageable proportions by simulating only those events and units that impact on the specific problem being investigated. The model proceeds on an event-to-event basis, rather than by discrete time intervals.

Vincent asked about the realism and accuracy of combat modeling. Bonder and Somers reassured him on this point. Models are not checked against real warfare, because needed data in adequate detail are not available. However, the models are checked against controlled field tests and are generally found to be reasonably representative of experimental results. Absolute values of system performance are not obtained. However, relative comparisons of different systems can be obtained. Changes in model outputs resulting from given change of input is the criterion used. The important contribution of modeling is that it takes account of the operational context in which the technology is used.

Harger: In assessing mine detection effectiveness, the cost of sensors destroyed during data acquisition missions is an important parameter.

Bonder: That is true. However, the computation is straightforward and the cost can be estimated separately from the model.

Wolfe: Does the BDM model account for intelligence available at all levels?

Somers: It includes representation of intelligence inputs at various decision levels.

Hollingsworth: Does the model account for the confusion that exists in command centers? At the lowest levels, soldiers are very much confused about the situation.

Bonder: As an adjunct to modeling procedures, we should be sure to take full advantage of existing operational studies done by other investigators. These will provide important insight into the problem and allow us to throw out approaches which will not be effective.

Harger: The model can be used in different ways. It not only can assess the effectiveness of specified mine detection techniques, but can be used to specify to the sensor technologists the required ranges of sensor parameters needed for effective operational results (as distinguished from purely technical effectiveness). Further, it can indicate sensitivity of operational results to variations in sensor parameters.

Bonder: It is important to do operational analyses at an early stage to give guidance to the sensor technologists. As a basis for this model, BDM and ERIM should get together and agree on significant parameters and needed inputs to the models to be used.

Somers: Specific parameters to be settled on as a means for interface between ERIM and BDM include the following:

(a) probability of detection of individual mines or complete minefields,

(b) coverage pattern of sensor,

(c) ability to discriminate between mines and other objects,

(d) reaction time of sensor missions,

(e) visibility of the target (topography, weather, vegetation, etc.),

(f) vulnerability of the platform at various altitudes and stand-off ranges.

Bonder: Instead of running the complete model for large numbers of system configurations, scenarios, etc., it might be better to study the problem in two stages. One stage would be parametric analysis to give specific information on the mine detection process and its closely related operational aspects. For sensor selection and design purposes, the models should be used by varying important parameters such as coverage, accuracy, response times, vulnerability, false alarm rate, etc. in sensitivity analyses. These variations should be restricted to performance regions in which there is reasonable expectation of developing sensor capability.

Results of this modeling would be of most use to the ERIM sensor technologist. The other stage of the study would evaluate the change in force effectiveness from use of the sensor technique. This second stage would use as inputs the probability of mine or minefield detection and the use of the information for neutralizing or bypassing minefields, and would generate, as output, force effectiveness results. Since many force-on-force effectiveness results exist with and without the use of mines, it might be possible to perform stage two of the study without making any new runs of an effectiveness model.

Recommendations of the EWG

General Hollingsworth summarized the major recommendations of the EWG. His summary was followed by comments and suggestions by individual members of the Group.

The work of the two contractors on the program (BDM and ERIM) should be coordinated by MERADCOM. MERADCOM should not take over the leadership

of the program, but should monitor the work of the two contractors and look for deficiencies in their performance so that corrections in the program can be made.

EWG will continue to work with the contractors to make recommendations on the direction of effort and to review the work of the contractors in meeting stated objectives.

The immediate need is to jointly prepare a comprehensive work plan which coordinates the objectives and activities of the two contractors. The overall work plan for the two contractors should be unified so that common objectives are reached, there is a clear separation of responsibilities, and coordination of individual tasks of the two contractors is assured. The work plan should state the information inputs and outputs of each task, the general approach to be taken in each task, and the interface between tasks. The work should be scheduled so that time compatibility of the various tasks is assured.

The program plan should specify technical opportunities in terms of several time frames. Current work in target detection by the Army, Navy, and Air Force should be looked at to determine opportunities in these various time frames. These opportunities should be divided into the following categories:

(a) target detection techniques presently in use,

(b) target detection techniques expected to be in inventory by 1985,

(c) target detection techniques available by 1990 or later.

Most of the items in the ERIM plan appear to fall in category (c).

The program plan should be ready for presentation in about 4 to 6 weeks. At that time, the EWG should meet again to review the plan.

The program plan should lead to the preparation of a Statement of Work for the two contractors provided by MERADCOM. This statement of work

may then have to be substituted for the existing statements in the contract.

Final Comments of the EWG Members

Bonder: The program plan for the system contractor should emphasize parametric analysis to provide insights on alternatives that are reasonable.

Wolfe: ERIM's work should include modeling of passive IR. Reflectivity measurements in the laboratory should precede or accompany rooftop measurements.

Olson: In assessing each type of technical opportunity, it will be very helpful to indicate in each case what performance parameter is limiting effectiveness, so that further investigations can be directed toward increasing performance in the appropriate direction.

Heimiller: Early effort should be concentrated on the use of simplified modeling to identify where optimum performance improvements can be made.

Some existing systems are not well defined. We need Army inputs providing information on current Army programs.

Paca: Operational analysis of systems and scenarios should define what the Blue commander will do in various scenarios.

ERIM needs to focus its effort on sensors that meet the various requirements for mine detection, both technical and operational.

Wolfe: An early analysis should be done on a sensor whose characteristics are already well known, as an efficient way of developing experience in mine detection analysis.

An additional summary of the recommendations of the EWG was prepared by Dr. Gonano, and is included as an attachment to this report.

4. RECOMMENDATIONS AND ACTION ITEMS

Organization Responsibilities

The overall minefield detection program should be coordinated and monitored by MERADCOM.

EWG will continue to work with the contractors to make recommendations on the direction of effort and to review the work of the contractors in meeting stated objectives.

Program Planning

A coordinated work plan should be prepared, task by task, defining activities of all organizations participating in the minefield detection program. It should show information inputs and outputs versus time, so the relationships between tasks can be coordinated. It should be ready for presentation and review by the EWG at the end of February.

Technologies addressed in the Program Plan should be grouped by IOC time frame, so that trade-offs can be evaluated more realistically. Detection systems should be categorized as (1) present systems, (2) IOC 1985 systems and (3) systems with IOC for 1990 and beyond.

A front-end analysis should be made to establish more clearly the critical issues and assumptions underlying the minefield detection program. These should be presented at the next EWG meeting.

The plan should be made specific with respect to screening procedures, test objectives, method of processing and evaluating experimental data, etc.

The program plan should lead to the preparation of a Statement of Work prepared by MERADCOM. This may have to be substituted for the existing statement of work in current contracts.

Scenarios

Scenarios should include the range of options available to the blue forces in response to red action.

A decision should be made on whether work is to be done on scatterable mines.

Selected scenarios should include slow-moving situations, since even low speed detection of mines will have valuable uses.

Identification and Screening

The project should consider a wide range of alternative methods of minefield detection, and should select the most promising alternatives in a well-defined and rational manner.

A survey should be made of the capabilities of existing data acquisition systems now in DoD inventory, as well as other systems currently under development.

ERIM should clearly identify and explain its underlying assumptions and screening methods. Screening methods should be sufficiently detailed to provide reliable differentiation of alternatives.

Several specific techniques recommended for initial screening are:

- gaseous detection methods
- diffraction effects at proper wavelength to detect minefield patterns
- multispectral classification of acoustic/seismic outputs for identifying minelaying operations
- analysis of movement patterns of minelaying vehicles through use of multiple acoustic/seismic sensors.

Preliminary Analysis

To provide experience in developing analytical methodology, ERIM will furnish technical characterization of a well-developed sensor type and this will be used to conduct a pilot operational analysis.

Specific items for preliminary analysis include the following:

- review R. Harger's report relating detectability of minefields to mine spatial density,
- passive IR systems.

Critical Data Acquisition

Both laboratory and field measurements should be conducted for active IR.

Landsat data should be collected before and after laying mines.

Investigation of square mines should be given low priority.

Analytical Methodology

Operational criteria and analytical methodology should be developed during the early stages of the program, to provide guidance in the screening and preliminary analysis of technical opportunities.

Operational studies performed by other investigators should be reviewed to provide guidance in developing the analytical methodology.

Analytical methodology should be developed for two types of use:

- parametric analysis to give specific information needed for sensor selection and design purposes, and
- operational analysis to evaluate the change in force effectiveness from use of a specific sensor technique.

The parametric analysis of proposed new systems should be performed to show where greatest gains can be made. This analysis should be directed toward identifying alternatives and sensitivities rather than evaluating systems.

Significant parameters and needed inputs to the modeling effort should be defined jointly by the sensor technologists and the operational analysts.

The analytical methodology should include consideration of vulnera-ability of sensor/vehicle combinations. This includes vulnerability of the platform to enemy fire, and vulnerability of the sensor to electromagnetic interference. The cost of sensors destroyed during data acquisition missions is an important evaluation parameter.

The methodology should include the performance of intelligence units, and realistically represent confusion and uncertainty existing at various decision levels.

ERIM

21 December 1978

MEMORANDUM FOR RECORD

SUBJECT: Expert Working Group Comments on Detection of Remote Minefields Effort

1. After briefings on operational considerations by MERADCOM and BDM, ERIM presented a proposed Project Plan for the EWG's consideration. Rather than address the technical and managerial issues in the Plan, the Group raised more fundamental questions about the relationship between the operational and the technical studies, and specifically about information linkages and time phasing. After an EWG executive session, the following points were made in a wrap-up session on 8 December.

2. GEN HOLLINGSWORTH: Those members new to the EWG had misconstrued the state-of-the-art; until near the end of the meeting they had assumed all systems discussed could have IOC in 5-8 years. He is concerned about coordination between contractors; a program plan should be developed cooperatively by MERADCOM, BDM, and ERIM for review by the EWG. Technologies addressed in the Program Plan should be grouped by IOC time frame so that trade-offs can be evaluated more realistically. The EWG should be reassured that we have considered all alternatives and that we have selected the most promising in a rational manner.

3. DR. BONDER: The EWG should see a work plan, task by task, for both contractors. It should show information inputs and outputs versus time, so the relationships between tasks can be coordinated. It should be prepared cooperatively by the three parties and reviewed by the EWG within a month to six weeks; certainly before April.

One should compare detectors in like time frame - e.g., present systems, IOC 1985 systems and IOC 1990 technologies. The operational analysis of proposed new systems should be parametric to show where greatest gains can be made. Operational analysis should be directed toward identifying alternatives and sensitivities rather than evaluating systems. It should be analysis rather than model building.

4. PROF WOLFE: For years we have been talking about modeling the performance of passive IR systems against buried mines. The data and techniques are now available and we should go ahead and do it. [For buried mines one understands from previous research fairly well what terrain and weather conditions permit detection. Since these conditions are limited, the salient question is the military value of such a system. J.R.G.] Both laboratory and field measurements are needed for active IR.

5. PROF OLSON: The fact that a specific parameter is the critical limiting parameter of a specific detection scheme depends upon the magnitude of all operational parameters; blindly improving one parameter may cause another parameter to become limiting with little net improvement. One must understand how all factors are related to actually improve a detector by wisely managing trade-offs.

6. MR. HEIMILLER: It is desirable to identify capabilities by specific IOC time frames; however, IOC is difficult to predict since it is subject to technical, fiscal, and political forces.

7. MR. PACA: The operational scenarios presented by BDM are reasonable; however, since they do not address the full range of options available to blue forces in response to red action they are incomplete. ERIM did not adequately show what types of detectors it considered, how it selected the most promising, or how it identified which data is still required. This process should be made more explicit in order to expose the underlying assumptions more clearly.

8. MR. DINGER: A front-end analysis should be made to establish more clearly the critical issues and assumptions. An EWG meeting should be held within two months to review this analysis and the plans for work coordination. For the new technologies, ERIM must focus on collecting data on the minefield problem.

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